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THE MINERAL INDUSTRY OF VIRGINIA IN 1965[1]

Paced by record-breaking outputs of coal and construction aggregates, the value of mineral output in Virginia in 1965 rose to a new high of $268 million, 13 percent greater than in 1964. Almost three-fifths of the mineral commodities produced gained in output; over four-fifths gained in value. Production and value of lime, sand and gravel, and stone reached new highs. An increased level of highway and other construction in 1965 was of prime influence in the increased output of sand and gravel and stone. Fifty-two percent of the total value of mineral production in Virginia was contributed by fuels, 45 percent by nonmetals, and 3 percent by metals, the same proportions as in 1964.

Virginia's fuel capability was increased by the opening of a new coal mine near Big Stone Gap, Wise County, by Stonega Division of Westmoreland Coal Company, with an expected annual output of 1.8 million tons at full capacity. Another coal development was Island Creek Coal Company's plans to develop a second mine in Buchanan County. The mine, scheduled to start late in 1967, is expected to produce 2 million tons of metallurgical coal annually and will be opened in the company's 500 million ton reserve area of Pocahontas No. 3 seam.

[1] Prepared by the Bureau of Mines, U. S. Department of the Interior, under a cooperative agreement with the Virginia Division of Mineral Resources, for collecting information on all minerals except fuels.

Mineral Fuels

Coal (Bituminous).—Spurred by a substantial gain in output in Dickenson County, coal production rose to 34 million short tons—8 percent more than in 1964, the previous record year. Production data includes coal produced from deposits within Virginia, whether the mine opening is or is not inside the State boundary, and excludes operations producing less than 1000 tons per year. Consequently, production data in this volume published by the Federal Bureau of Mines may differ somewhat from data published by the State. The value of the output increased 13 percent over that of 1964, due partly to a 5-percent rise in average value per ton ($4.09) in 1965 over the $3.89 in 1964. The total value, however, was 10 percent below the 154 million reported in the peak value year, 1957.

Both high- and low-volatile bituminous coals were produced for domestic and industrial purposes and for export. A small tonnage of semianthracite coal was mined in Montgomery County. Forty-five percent of Virginia's coal tonnage was produced in one county—Buchanan; 63 percent of the State's coal mines were in Buchanan

Effective September 1, 1966, a 3-percent sales tax is required on all publications and maps purchased at the Division of Mineral Resources or for orders being mailed to addresses in Virginia.

Table 1.—Mineral production in Virginia.[1]

Mineral	1964 Quantity	1964 Value (thousands)	1965 Quantity	1965 Value (thousands)
Clays, thousand short tons	1,440	$ 1,614	1,415	$ 1,657
Coal (bituminous), do.	31,654	123,123	34,053	139,291
Gem stones	NA	6	NA	7
Lead (recoverable content of ores, etc.), short tons	3,857	1,010	3,651	1,139
Lime, thousand short tons	780	9,781	847	10,584
Natural gas[2], million cubic feet	1,609	479	P 3,152	P 530
Petroleum (crude), thousand 42-gallon barrels	6	W	4	W
Sand and gravel, thousand short tons	10,588	13,722	15,322	18,019
Soapstone, short tons	3,775	9	3,549	9
Stone, thousand short tons	30,407	52,153	36,350	59,397
Zinc (recoverable content of ores, etc.)[3], short tons	21,004	5,700	20,491	5,942
Value of items that cannot be disclosed: Aplite, portland cement, masonry cement, feldspar, gypsum, iron ore (pigment material), kyanite, salt, titanium concentrate (ilmenite and rutile), and values indicated by symbol W	—	29,818	—	30,990
Total	—	$237,415	—	$267,565

P Preliminary. NA Not available. W Withheld to avoid disclosing individual company confidential data.

1 Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

2 Production data collected by the Bureau of Mines represents pipeline shipments; the production data recorded by the Virginia State Department of Labor and Industry, Division of Mines, was 1882 million cubic feet in 1964 and 4210 million cubic feet in 1965.

3 Recoverable zinc valued at the yearly average price of prime western slab zinc, East St. Louis market. Value established after transportation, smelting, and manufacturing charges have been added to the value of ore at the mine.

County. Four of the eight southwestern counties in which coal was mined—Buchanan, Dickenson, Wise, and Russell—accounted for 97 percent of the total output, compared with 98 percent in 1964. Underground production comprised 86 percent of the total (88.7 percent in 1964); strip-mine output, 9 percent (7.7 percent in 1964); and auger-mine production, 5 percent (3.6 percent in 1964).

In 1965 the number of mines in Virginia totaled 1271, 9 percent fewer than in 1964. Underground mines declined 11 percent to 1153, while the number of strip and auger mines rose to 56 and 62, respectively, compared with 44 and 56 in 1964. The tonnage of mechanically loaded coal was 57 percent of the total underground output, 12 percent higher than in 1964, reflecting the continuing trend toward modernization and mechanization in underground mining in Virginia. Sixty-four percent of the mechanically loaded tonnage was by 177 mobile loading machines (50 more than in 1964); 35 percent was by 56 continuous mining machines (25 more than in 1964); and the remaining 1 percent by hand-loaded face conveyors. Of the total coal mined, 50 percent was mechanically cleaned in 33 cleaning plants (5 more than in 1964). Wet washing other than with jigs was the principal method of cleaning, accounting for 76 percent of the cleaned coal. Thirty-five percent of the cleaned coal was thermally dried. Thirty-five percent of the total coal mined was crushed. Nine percent of the total coal produced was treated with dust-allaying and antifreezing preparations, of which oil predominated (96 percent).

Coke.—Beehive-coke was produced in five plants (five companies), four in Wise County and one in Buchanan County.

Petroleum and Natural Gas.—Natural gas produced for all uses and delivered to pipelines in 1965 totaled 4210 million cubic feet, according to the Virginia State Department of Labor and Industry, Division of Mines and Quarries. Tazewell County led in output, producing 58 percent; Buchanan and Dickenson produced 28 and 14 percent, respectively. The output from Buchanan and Tazewell counties was delivered to the pipelines of Hope Natural Gas Company and the Atlantic Seaboard Line; production from Dickenson County was delivered to the lines of the Kentucky-West Virginia Gas Company. There were no natural-gas-processing plants operating in Virginia as of January 1, 1965. Natural-gas reserves were estimated by the American Gas Association to total 32,467 million cubic feet, an increase of 296 million cubic feet or almost 1 percent more than the estimated reserve at the end of

1964. As of December 31, 1965, according to the Virginia Division of Mines and Quarries, there were 99 producing gas wells in Virginia as compared to 103 in 1964. Of significance was the completion of the first full year of gas delivery from Tazewell County from 12 wells completed in 1961, 1964, and 1965. There was only one well started in Buchanan County in 1965, and there were no new well completions; there was no drilling in Dickenson County in 1965. In Rockingham County, the Shell Oil Company and others drilled an unsuccessful test well to a depth of 14,176 feet in the Bergton gas field, exceeding the previous depth record in Virginia by 4836 feet.

Oil production in Lee County (Rose Hill and Ben Hur fields) decreased from 5828 barrels in 1964 to 3617 barrels in 1965. Two dry holes were drilled in Lee County in 1965.

Washington Gas Light Company operated LP gas storage facilities in Fairfax County. Storage capacity in a mined cavity (granite) for propane was rated at 300,000 barrels (as of January 1, 1966). The American Oil Company operated a skimming, cracking, and coking plant at Goodwin Neck, York County. The plant had a crude-oil capacity of 38,000 barrels, a catalytic-cracking capacity of 22,800 barrels, and a catalytic-reforming capacity of 6800 barrels, all per calendar day. The total gasoline output capacity was 14,100 barrels per calendar day.

Nonmetals

Aplite.—Output and value of aplite for glass manufacture increased. Production was from Hanover and Nelson counties.

Cement.—Shipments and total value of portland cement decreased slightly in 1965; unit value was slightly higher. Masonry-cement shipments increased 3 percent and total value rose 5 percent. The greater gain in total value was due to an increase (2 percent) in unit value in 1965. Portland cement plant capacity remained virtually unchanged during the year. The wet process of manufacturing portland cement was used by one plant, and two plants used the dry process. Four plants manufactured cement; three plants made both portland and masonry cement, and one plant produced only masonry cement. The cement was produced in Augusta, Botetourt, and Warren counties and the City of Chesapeake.

The cement producers mined limestone, shale, clay, and calcareous marl for their own use. Materials purchased for use in cement manufacture included sand, gypsum, oyster shells, mill scale, various air-entraining compounds, and various grinding aids.

Types I-II (general-use and moderate-heat cements) comprised the bulk of portland cement produced and marketed; both air-entrained and non-air-entrained types were produced. High-early-strength cement was also produced and shipped. Most of the shipments were in bulk and made by railroad, but sizable bulk shipments were also made by truck. Shipments of cement in containers (paper bags) were also sizable and were made by railroad and truck.

The distribution of portland cement for various consumer uses was as follows: 66 percent to ready-mix concrete companies (59 percent in 1964); 17 percent to concrete-products manufacturers (19 percent in 1964); 11 percent to contractors, including highway contractors (15 percent in 1964); 6 percent to other users, including building-material dealers, Federal, State, and local government agencies, and miscellaneous customers (7 percent in 1964). Marketing areas for portland cement were chiefly Virginia, North Carolina, West Virginia, Maryland, and Alabama. The bulk of masonry cement was shipped to Virginia, North Carolina, the District of Columbia, Maryland, and West Virginia.

Clay.—Production of clay was 2 percent lower than in 1964, but a new record was set for value, which exceeded that of 1964, the previous record year, by 3 percent. Nearly two-thirds of the clay and shale output was consumed in brick manufacture, compared with a little over one-half in 1964. The principal uses for the balance were lightweight aggregate and the manufacture of portland cement; some was consumed in the making of vitrified sewer pipe, flue linings, pottery, clay dummies, and other heavy clay products. Clay production was reported from 21 operations in 15 counties. The chief clay-producing counties in order of tonnage mined were Botetourt, Russell, Nansemond, Chesterfield, and Orange; in order of output value they were Botetourt, Orange, Prince William, Nansemond, and Chesterfield.

Feldspar.—Production was by one company in one county (Bedford). The combined output from several mines increased 13 percent compared with that of 1964, while the average value per ton remained the same. Mixed and potash feldspar

were mined. Feldspar, processed and ground at the company mill in Bedford, was marketed chiefly in Maryland, Ohio, New Jersey, New York, and Pennsylvania, principally for pottery and enamel manufacture, although smaller quantities were used in the manufacture of welding-rod coatings, soaps and abrasives, and other uses.

Gem Stones.—Agate, amazonite, blue corundum, lepidolite, olivine, staurolite, and unakite were among the gems and mineral specimens gathered by mineral collectors and hobbyists.

Gypsum.—Production of gypsum increased moderately. The crude material, mined at Plaster-co, Washington County, and near Chatham Hill, Smyth County, was calcined and manufactured into plasterboard and other gypsum products by United States Gypsum Company at their Plaster-co plant. The company also processed imported gypsum at a plant near Norfolk. Imported gypsum was ground by several firms in the Norfolk area for use as a land dressing.

Kyanite.—Production of crude kyanite ore increased substantially. Sales of the refined material to manufacturers of refactories and other ceramic products also increased substantially. Two mines and three processing plants were operated by the Kyanite Mining Corporation in Buckingham and Prince Edward counties, and the company also operated a grinding and bagging plant in the latter county.

Lime.—All-time highs in production and value of lime were set in 1965; lime output and value were 9 and 8 percent greater, respectively, than in 1964, the previous record year. The gains were attributed chiefly to the continually increasing demand for lime in chemical and other industrial uses. Sales of building lime increased, while sales of agricultural lime declined, compared with 1964. All but 5 percent of the lime sold or used, including both quicklime and hydrated lime, was consumed in chemical and industrial uses. Quicklime comprised 92 percent of the total production and hydrated lime the balance. Lime production was reported by nine companies in seven counties; Giles, Smyth, and Shenandoah counties were the chief lime-producing areas. Processing equipment used in lime manufacture included pot, shaft, and rotary kilns and batch and continuous hydrators. Fuel used in calcining included natural gas, bituminous coal, and coke. Uses for quicklime included the manufacture of calcium carbide, paper, and alkalies, flux in steel manufacture, and agricultural lime. Hydrated lime was marketed principally for use in the purification and treatment of water, leather tanning, sewage and trade-waste treatment, construction, and agriculture. Principal marketing areas included the District of Columbia, Florida, Georgia, Kentucky, Maryland, Michigan, North and South Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Mica.—No sales of crude mica were reported. Domestic and foreign scrap mica were ground by Richmond Mica Corporation, Newport News, for use in paint, rubber, wallpaper, plastics, and other products. This company was dissolved about June, 1965, and operations were continued at the site by the two surviving and associated companies, Asheville Mica Company, and Mica Company of Canada (N. Y.), Inc.

Nitrogen Compounds.—Allied Chemical Corporation, Nitrogen Division, Hopewell, Prince George County, produced nitrogen compounds for use chiefly as fertilizer ingredients.

Perlite.—Virginia Perlite Corporation, Hopewell, Prince George County, expanded out-of-State perlite (and vermiculite) chiefly for use as a lightweight concrete aggregate and building plaster.

Salt.—Olin Mathieson Chemical Corporation, Saltville, Smyth County, produced chlorine, caustic soda, soda ash, and other chemicals from brine recovered from nearby captive salt wells. Production of salt was comparable to the output in 1964.

Sand and Gravel.—New record highs were established for output and value of sand and gravel in 1965. Output exceeded that in 1964, the previous year of record production, by 45 percent, while value was 2 percent greater than in the former peak year of 1963 and 31 percent greater than in 1964. Demand for sand and gravel used in building and road construction was largely responsible for the increase in output; production of commercial sand and gravel used in paving was substantially higher than in 1964.

Paving and building uses comprised 78 percent of the commercial production (53 percent paving, 25 percent building). Other sand and gravel uses included glass sand, engine sand, filtration sand, railroad ballast, fill material, and sand and gravel for miscellaneous uses. Commercial output comprised 99.9 percent of the total production and virtually all of the value. The small remainder

of the total output (0.1 percent) was State and local Government production (2 percent in 1964). Sand comprised 59 percent of the total commercial sand and gravel output and 46 percent of the commercial value. Sixty-nine percent of the total commercial sand and gravel output was washed, screened, or otherwise prepared, as compared with 84 percent in 1964. Seventy-three percent of the commercial tonnage was shipped by truck, and most of the remanider by waterway or railroad; a small quantity was used at the producing plants or transported by unspecified methods.

Sand and gravel production was reported from 31 counties and 2 independent cities. In order of decreasing output, the principal sand and gravel producing areas were Fairfax, City of Virginia Beach, Chesterfield, Henrico, and Prince George. Over four-fifths of both the total output and value was contributed by these five producing areas. Of the 51 commercial sand and gravel operations reported during 1965, 4 with an output range of 1,000,000 tons or over accounted for 53 percent of the output; 4 with an output range of from 500,000 to 1,000,000 tons accounted for 19 percent; 13 with an output range of from 100,000 to 500,000 tons accounted for 20 percent; 12 with an output range of from 50,000 to 100,000 tons accounted for 6 percent; and 18 with an output range of up to 50,000 tons accounted for 2 percent.

Soapstone.—Crushed and ground soapstone was produced by one firm in Franklin County. The principal uses of the product were insecticides and foundry facings. Soapstone used as a dimension stone is included with miscellaneous stone in the stone section of this chapter.

Stone.—Continuing its increasing trend, Virginia's stone production in 1965 broke all records in both quantity and value for the eighth consecutive year. Stone, the second most important mineral commodity produced in Virginia, in 1965 surpassed coal (traditionally the leading mineral in both tonnage and value) in output but not in value. Production totaled 36.4 million tons valued at $59.4 million, a gain of 20 percent in output and 14 percent in value over 1964. Contributing most to the gain in output were increases in the production of limestone (14 percent over that of 1964) and granite (24 percent over that of 1964). Limestone and granite, the leading stone types, accounted for more than five-sixths of the total stone tonnage and more than three-quarters of the value. The substantially greater demand for concrete aggregate and roadstone was the major reason for the rise in output of both limestone and granite, reflecting a higher rate of building and local and interstate highway construction than in 1964. Crushed or broken material was chiefly produced; only a limited amount of dimension limestone and no dimension granite production was reported in Virginia in 1965. Basalt (including traprock and diabase), the third leading stone produced in Virginia, and sandstone both increased substantially in output and value due mainly to the strong demand for the crushed material as construction aggregates; limited amounts of dimension basalt and sandstone were also produced. Production and value of miscellaneous dimension stone, including soapstone and "Virginia Greenstone," decreased; no production of the crushed material was reported in 1965. Crushed slate production and value declined moderately, while output and value of the dimension product increased substantially, due in large measure to increased demand for wall facing and flooring material both for domestic and foreign markets.

Many types of stone were mined or quarried in Virginia, including limestone, granite, basalt (including traprock and diabase), sandstone, slate, calcareous marl, miscellaneous stone, and marble, in order of decreasing output. Seventy-four percent of the total stone output was used as concrete aggregate and roadstone (71 percent in 1964); 11 percent in the manufacture of cement and lime; 3 percent as metallurgical fluxstone; and the remaining 12 percent for uses such as stone sand, railroad ballast, riprap, and agricultural dressings. Limestone, either as such or as lime, had additional application in the chemical, glass, and paper industries. Marine shell, a substantial tonnage of which was dredged from the Chesapeake Bay area, together with a limited quantity obtained as a product of oyster and other mollusk processing, was used mainly as an aggregate in road construction, in the manufacture of cement and lime, and as an agricultural liming material. Roofing granules were produced from crushed slate by a firm in Buckingham County. Output of limestone, granite, and basalt—the three leading stone types produced—accounted for over nine-tenths of the total stone production. Crushed or broken material comprised virtually all (99.8 percent) of the total stone output and 92 percent of the total value. In terms of production, dimension stone accounted for 0.2 percent; in terms of value, for 8 percent.

The principal stone-producing counties, in terms of tonnage, were Shenandoah, Frederick, Botetourt, Loudoun, and Augusta (Frederick, Botetourt, Loudoun, Wythe, and Roanoke counties in 1964). In terms of product value, the most important counties were Frederick, Giles, Shenandoah, Loudoun, and Botetourt (Frederick, Botetourt, Nelson, Loudoun, and Giles in 1964). Fifteen counties produced more than 1 million tons of output compared with 10 in 1964 and 8 in 1963, and there were 25 counties with production valued at more than $1 million each (22 in 1964, 18 in 1963). Commercial stone was reported in 53 counties, compared with 48 in 1964, and Government-and-contractor stone was produced in 7 counties (9 in 1964).

Metals

Ferroalloys.—Ferromanganese was produced by blast-furnace reduction of imported ore by E. J. Lavino and Company, Furnace Division, near Lynchburg.

Iron Ore (Pigment Material).—Crude brown and yellow iron-oxide pigments were produced by one firm near Hiwassee, Pulaski County. This firm also produced, near Hiwassee and Pulaski, brown, red, and yellow natural iron-oxide pigments and a variety of finished natural and manufactured pigments. The materials used for pigment manufacture included manufactured oxides, imported oxides, and iron oxides from local deposits. Iron-oxide pigments were also produced from imported hematite by another firm near Henry, Franklin County. Total marketed output of iron-oxide pigments increased substantially.

Lead and Zinc.—Production of lead and zinc ore was limited to two mines in Wythe County. The tonnage of both lead and zinc recovered was less than in 1964, but the value of both commodities increased. Lead and zinc output declined 5 percent and 2 percent, respectively; the value, however, rose 13 percent and 4 percent, respectively, due to higher unit prices prevailing in 1965.

Titanium Concentrates.—Continuing an increasing trend, marketed production of titanium concentrates (ilmenite and rutile) gained substantially in both output and value. Shipments of both ilmenite and rutile increased substantially. Ilmenite was produced by American Cyanamid Company, Pigments Division, in Amherst County, and both ilmenite and rutile were produced by M & T Chemicals Inc., in Hanover County.

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NEWS NOTES

The National Gypsum Company will begin expansion of the company's lime plant and related operations at Kimballton, Giles County. New facilities will include additional mining and crushing equipment and a third kiln. A complete dust-collecting system will be incorporated in the expanded facilities. The new equipment will nearly double present capacity.

The Foote Mineral Company is developing a second underground mine in limestone at Kimballton, Giles County. The new mine, to be in production in 1967, will supply limestone for use in the company's adjacent lime plant. A new kiln, also to be in operation in 1967, will substantially increase production of lime.

The Lonesome Pine Stone Company, Inc., is operating a quarry in limestone at East Stone Gap, Wise County. The stone is crushed and utilized as aggregate and for agricultural purposes.

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ADDITION TO STAFF

Mr. Richard S. Good joined the Division staff on September 1, 1966, and will assist with mineralogic and geochemical studies. He received a B.S. degree in geology in 1950 and an M.S. degree in geology in 1955, both from Pennsylvania State University; while there, he worked for the Atomic Energy Commission on the geochemistry of uranium-bearing lignites and on geochemical prospecting for nickel and copper in soils and plants. Two additional years of graduate work were spent in the study of metamorphic rocks.

Mr. Good worked as an exploration geologist in Canada, largely mapping and supervising diamond drilling in areas of Precambrian rocks, for Geo-Technical Development Company, Ltd. of Toronto. He later worked as a photogeologist and field geologist for Hunting Technical Services, Ltd. of London on a 2-year mapping project in East Africa in the southwest rift area of Tanganyika (Tanzania). More recently, Mr. Good has worked as an analytical chemist for Kawecki Chemical Company in Philadelphia. He is married.

PREDICTED LOWERING OF ARTESIAN WATER LEVELS SOUTH OF THE JAMES RIVER

The Atlantic Coastal Plain is a productive ground-water region, and in the Virginia portion major new supplies could be developed even though large withdrawals are now being made in some areas. The magnitude of such withdrawals together with possible sea-water encroachment are principal factors limiting the development of ground-water reserves.

Along the Fall Line, which passes south from Washington near Richmond and Emporia, the thin unconsolidated Coastal Plain sediments are composed mostly of alternating layers of sand and clay. These sediments are slightly inclined toward the sea and become thicker in an eastward direction. South of the James River recent developments have increased the quantity of water being withdrawn from aquifers that are present. Near Franklin, for example, the 900 feet of sedimentary strata are divided roughly into three groups. The upper (near-surface) group consists of a relatively thin series of sand beds interbedded in places with layers of clay; the middle group, about 100 feet thick, is composed of layers of impermeable marl and clay; the lower (deepest) group is composed of a thick series of sand and clay strata of Cretaceous age. Ground water stored in the Cretaceous sands is under artesian pressure, and the water level in wells will rise above the bottom of the overlying layers of marl and clay. These confining layers of marl and clay prevent rapid vertical movement of ground water between the Cretaceous aquifers and the sands that occur near the ground surface. The near surface sands are also water bearing. In most places, the water in these shallow aquifers occurs under water-table conditions. However, in areas where interbedded clays occur, the lower layers of sand in the upper group of sediments may contain water under artesian pressure. In low-lying areas, some of the wells screened in these upper-group artesian sands flow at the land surface. The shallow artesian sands and the water-table sands form an hydraulic system that is more or less independent of the underlying Cretaceous aquifers. Thus, the fluctuation of the water table is not controlled by the rise and fall of the artesian pressure in tightly cased and grouted wells that penetrate one of the deeper aquifers beneath the middle group of confining beds.

The aquifers in the upper part of the Cretaceous age deposits have been penetrated by wells for many years and withdrawals of ground water from them in the vicinity of Franklin during the past 25 years have lowered the local artesian pressure surface. It is estimated that withdrawal of ground water in the Franklin area since 1942 has lowered the artesian pressure in aquifers over an area of approximately 1280 square miles, which extends 20 miles west, north, and east and 12 miles south of Franklin. The average decline of the artesian pressure surface within this area is about 35 feet. The decline in the vicinity of Franklin, however, has been 100 feet. It has been calculated that the decrease in ground-water storage in the Cretaceous aquifers since 1939 has been 9.5 billion gallons, but the total withdrawal in the Franklin area has been 150 billion gallons. These quantities indicate that 90 percent or more of the withdrawal has been from recharge to these aquifers, and 10 percent or less from storage.

Even though the withdrawals in the Franklin area have been large, the water levels in all wells screened in the Cretaceous aquifers are considerably above the top of the impermeable confining layer. Thus, all of the water-bearing beds in the artesian system are still completely saturated. However, the reduction of artesian pressure has resulted in a slight compaction of the aquifers and associated beds. This compaction has caused a small reduction in the porosity of the aquifers. Thus, the water released from storage, 9.5 billion gallons, was literally squeezed out. Most of the decline of artesian pressure caused by withdrawals from confined aquifers occurs during the first few weeks or months after pumping is begun. Thus, most of the compaction and concurrent release of water from storage occurs relatively soon after pumping is begun. Later on, when the pressures have essentially stabilized, almost all, if not all, of the water pumped is derived from recharge.

Examinations of sample cuttings collected from the formations at the time the six new Union Camp Corporation wells were drilled and of several geophysical logs of wells in the Franklin area indicate the aquifers in the upper portion of the Cretaceous sediments have an average thickness of about 200 feet. The quantity of water, therefore, in a cylinder 50 miles in diameter, filled to 200 feet with sand that has an effective porosity of 20 percent, is about 16,800 billion gallons. Potential withdrawals at volumes many times the current rate are indicated. Considering the

possibility of recharge equal to 90 percent of the withdrawals, several hundreds of years may be projected for use of the Cretaceous aquifers.

Continued withdrawals from the Cretaceous aquifers are anticipated to gradually decrease the artesian pressure surface. Although the expanded well field of the Union Camp Corporation at Franklin utilizes aquifers between 380 and 865 feet, it may be predicted that after 2 years of continuous pumping the pressure surface will decline in the Cretaceous aquifers. The amount of greatest decline will be in the vicinity of the well field. In February and March 1964, the pressure surface of water in wells near this well field was 100 feet below sea level. With continued pumping it is expected this surface will have been lowered an additional 50 feet by the fall of 1968 and beyond that time may decrease further but at a slower rate. At a distance of 20 miles from Franklin it is anticipated the artesian pressure surface will be lowered 10 feet, with the amount of lowering increasing toward the Franklin well field.

As a result of large withdrawals from artesian aquifers mutual interference may occur between wells that are pumped concurrently. Such withdrawals may decrease the pressure surface below the intake pipe in some wells, a condition that may be corrected by lowering the intake pipe and in some cases by installing a pump with sufficient capacity to lift water from greater depths. In other cases, it may not be possible because of well design, to lower the pump sufficiently; and therefore it may be necessary to reconstruct the well or drill a new well and install a pump that has the capacity to lift the water the additional distance.

Much of the information contained in this article was abstracted from several reports prepared by Leggette, Brashears and Graham, Consulting Ground Water Geologists.

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U.S. BUREAU OF MINES WORK-STUDY PROGRAM FOR GRADUATE STUDENTS

Walter R. Hibbard, Jr., Director of the U. S. Bureau of Mines, recently announced that the Bureau will pay graduate students in the mining, metallurgical, and petroleum engineering fields while they work on graduate research projects. Under a new cooperative program, students can be paid up to 20 hours a week while attending classes and receive full-time pay during the summer. To be eligible for the program, a student must be a candidate for an advanced degree and a U. S. citizen. He must also choose a research project approved by the Bureau. Students may either work at a USBM station or on the campus of the institution they are attending. In the latter case, the Bureau employs a faculty member to supervise the student's project. The students will receive an hourly rate based on the annual salary for a Civil Service rating given him at the time of his employment. Master's degree candidates will for the most part be given GS 5 or 7 ratings, which command $6207 and $7304 a year, respectively. Doctoral candidates will generally receive a GS 9 rating, which has a base salary of $7733 a year. The Bureau determines the hourly rate for these pay scales. Faculty members employed as supervisors will be given GS 11 to 13 ratings and work about 10 hours a week in their supervisory capacity. For further information, interested persons may contact the nearest USBM station or write to Dr. Walter R. Hibbard, Jr., Director, U.S. Bureau of Mines, Washington, D. C.

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GEOGRAPHIC NAMES IN VIRGINIA

It is the purpose of the United States Board on Geographic Names to render formal decisions on new names, proposed changes in names, and names that are in conflict which are submitted for decision by individuals, private organizations, or government agencies. Communications about these names should be addressed to: J. O. Kilmartin, Executive Secretary, Domestic Geographic Names, U. S. Geological Survey, Washington, D. C. 20242.

An asterisk (*) preceding a name represents a change in an earlier decision; a dagger (†) preceding a name indicates modification of the text of a former decision.

**Assawoman*: village, 3.5 miles east of Hallwood and 9 miles southwest of Chincoteague; Accomack County, Virginia; 37°52′25″ N., 75°31′35″ W. Not: Assawaman (former decision).

**Assawoman Creek*: stream, 10 miles long, heads at 37°54′57″ N., 75°32′15″ W., flows south-southeast to the Atlantic Ocean 10 miles southwest of Chincoteague; Accomack County, Virginia; 37°49′10″ N., 75°29′55″ W. Not: Assawaman Creek (former decision).

**Assawoman Inlet*: inlet, 0.2 mile long, separating Wallops Island and Assawoman Island 10 miles southwest of Chincoteague; Accomack County, Virginia; 37°49'10" N., 75°29'55" W. Not: Assawaman Inlet (former decision).

**Assawoman Island*: island, 4 miles long, along the Atlantic coast, 0.1 mile north of Metomkin Island and 10.5 miles southwest of Chincoteague; Accomack County, Virginia; 37°47'30" N., 75°31'10" W. Not: Assawaman Island (former decision).

Big Chestnut Creek: stream, 23 miles long, heads at 36°52'45" N., 80°56'40" W., flows east-northeast to the Pigg River 10 miles east-southeast of Rocky Mount; Franklin County, Virginia; 36°55'50" N., 79°44'16" W. Not: Chestnut Creek.

Bill Browns Creek: inlet, 0.5 mile long, opens into the Southwest Branch Severn River, just north of Rowes Point and 1.8 miles north of Achilles; Gloucester County, Virginia; 37°18'23" N., 76°26'19" W.

Black Branch: stream, 1 mile long, heads at 37°29'55" N., 80°17'10" W., flows south-southwest to Grannys Creek at the settlement of Craig Springs; Craig County, Virginia; 37°29'02" N., 80°17'17" W.

**Blows Creek*: stream, 1 mile long, flows south-southwest to the James River 9 miles southwest of Yorktown; City of Newport News, Virginia; 37°08'36" N., 76°37'04" W. Not: Chisholm Creek (former decision), Chisholm's Creek, Christholm Creek, Christholm's Creek, Crisholm Creek, Cristholm's Creek.

Burke Mill Stream: stream, 6 miles long, heads at 37°27'54" N., 76°29'03" W., flows north, then east, then south-southeast, to join North End Branch to form North River 3.5 miles north-northeast of Ware Neck; Gloucester and Mathews counties, Virginia; 37°27'13" N., 76°26'33" W. Not: North End Branch (q. v.).

†Cliff Mountain: mountain, elevation 3000 feet, in Shenandoah National Park, 10 miles east-southeast of Shenandoah; Greene County, Virginia; 38°26'40" N., 78°26'55" W. Not: Stallion Cliff Mountain.

Dragon Run: stream, 7 miles long, heads at 37°48'40" N., 76°56'57" W. flows east-southeast to Dragon Swamp 9 miles south-southeast of Tappahannock; Essex and King and Queen counties, Virginia; 37°47'54" N., 76°50'30" W. Not: Dragon Swamp (q. v.).

Dragon Swamp: stream, 40 miles long, heads at 37°46'50" N., 76°56'40" W., flows southeast to the head of the Piankatank River, in Meggs Bay, 3 miles south-southeast of Saluda; Essex, Gloucester, King and Queen, and Middlesex counties, Virginia; 37°34'03" N., 76°34'31" W. Not: Dragon Run (q. v.).

Georges Swamp Branch: stream, 1 mile long, heads at 37°29'25" N., 80°19'30" W., flows south-southeast to West Branch Grannys Creek 1.2 miles west-southwest of the settlement of Craig Springs; Craig County, Virginia; 37°28'40" N., 80°18'42" W. Not: Hog Rock Branch (q. v.).

Goddins Pond: lake, 1 mile long, 4 miles south of the town of West Point and 36 miles east-southeast of Richmond; New Kent County, Virginia; 37°28'43" N., 76°47'55" W. Not: Bradenham Pond, Goddins Mill Pond, Gordon Pond.

Golf Course Branch: stream, 1 mile long, heads at 37°29'50" N., 80°17'55" W., flows southeast to Black Branch just east of the settlement of Craig Springs; Craig County, Virginia; 37°29'10" N., 80°17'12" W. Not: Black Branch (q. v.).

Grannys Creek: stream, 2 miles long, heads at confluence of Kale Branch and an unnamed stream, flows southeast to Johns Creek 1 mile south-southeast of the settlement of Craig Springs; Craig County, Virginia; 37°28'19" N., 80°16'42" W. Not: Grannys Branch, Grannys Run, Kale Branch (q. v.).

**Hardens Bluff*: bluff, on the east side of the James River, 5 miles north-northeast of Hopewell and 18 miles south-southeast of Richmond; Charles City County, Virginia; 37°22'05" N., 77°14'35" W. Not: Hardins Bluff (former decision), Hardy's Bluff.

Haring Swamp: stream, 1.8 miles long, heads just southwest of Magruder, flows southeast to Queen Creek 3 miles northeast of Williamsburg; York County, Virginia; 37°18'12" N., 76°39'42" W. Not: Harring Swamp.

Healing Branch: stream, 1.5 miles long, heads at 37°29'58" N., 80°18'28" W., flows southeast to Grannys Creek 0.8 mile west-northwest of the settlement of Craig Springs; Craig

County, Virginia; 37°29′02″ N., 80°17′31″ W.

Heywood Creek: inlet, 1.2 miles long, opens into the Southwest Branch Severn River just west of Thorntons Creek and 1.1 miles northwest of Achilles; Gloucester County, Virginia; 37°17′30″ N., 76°27′19″ W.

Hog Rock Branch: stream, 0.5 mile long, heads at 37°28′55″ N., 80°20′05″ W., flows south-southeast to join Wide Hollow at the head of West Branch Grannys Creek, 2 miles west-southwest of the settlement of Craig Springs; Craig County, Virginia; 37°28′30″ N., 80°19′35″ W. Not: Wide Hollow (q. v.).

Holly Bush Creek: inlet, 0.4 mile long, opens into the Southwest Branch Severn River just south of Rowes Point and 1.5 miles north of Achilles; Gloucester County, Virginia; 37°18′07″ N., 76°26′28″ W.

Kale Branch: stream, 1 mile long, heads at 37°29′38″ N., 80°19′10″ W., flows southeast to join an unnamed stream to form Grannys Creek 0.8 mile west-northwest of the settlement of Craig Springs; Craig County, Virginia; 37°29′10″ N., 80°18′23″ W. Not: Grannys Creek (q. v.), Kates Branch, Laurel Branch.

King Creek: stream, 6 miles long, heads at 37°14′25″ N., 76°38′46″ W., flows northeast to the York River 6 miles east of Williamsburg; York County, Virginia; 37°16′30″ N., 76°35′00″ W. Not: Whiteman Swamp (q. v.).

Lady Creek: inlet, 0.3 mile long, opens into the Southwest Branch Severn River 0.2 mile west of Rowes Creek and 1.4 miles north-northwest of Achilles; Gloucester County, Virginia; 37°17′55″ N., 76°26′53″ W.

Little Chestnut Creek: stream, 1.5 miles long, heads at the junction of its North and South Forks, flows southeast to Big Chestnut Creek 8 miles south-southeast of Rocky Mount; Franklin County, Virginia; 36°53′43″ N., 79°49′45″ W.

Little Toms Cove: cove, 0.4 mile across, at the south end of Assateague Island, in the northeast part of Toms Cove, 3 miles south-southeast of Chincoteague; Accomack County, Virginia; 37°53′15″ N., 75°20′55″ W. Not: Fykes Cove, Old Cove, Old Toms Cove.

London Bridge: village, 6 miles south-southwest of Cape Henry and 12 miles east-southeast of Norfolk; City of Virginia Beach, Virginia; 36°50′30″ N., 76°03′00″ W. Not: Londonbridge.

Lugar Hill: hill, 1.4 miles southwest of Simmonsville and 10 miles north-northeast of Blacksburg; Craig County, Virginia; 37°22′17″ N., 80°22′47″ W.

Merrimac: settlement, 2.8 miles south of Blacksburg and 4 miles north-northwest of Christiansburg; Montgomery County, Virginia; 37°11′30″ N., 80°25′35″ W. Not: Merrimac Mines.

Middle Branch: stream, 1 mile long, heads at 37°29′15″ N., 80°19′46″ W., flows south-southeast to West Branch Grannys Creek 1.5 miles west-southwest of the settlement of Craig Springs; Craig County, Virginia; 37°28′35″ N., 80°19′03″ W.

Middle Creek: stream, 2 miles long, heads at 37°27′19″ N., 80°24′22″ W., flows southeast to Little Oregon Creek 0.7 mile north-northwest of Maggie; Craig County, Virginia; 37°25′54″ N., 80°23′14″ W. Not: Porterfield Branch (q. v.).

North End Branch: stream, 5 miles long, heads at 37°29′15″ N., 76°23′45″ W., flows southwest to join Burke Mill Stream to form North River 3.5 miles north-northeast of Ware Neck; Mathews County, Virginia; 37°27′13″ N., 76°26′33″ W. Not: Morgans Branch.

North Fork Little Chestnut Creek: stream, 9 miles long, heads on the south side of Thornton Mountain, flows northeast, then south-southeast, to join South Fork Little Chestnut Creek to form Little Chestnut Creek 7 miles south-southeast of Rocky Mount; Franklin County, Virginia; 36°54′20″ N., 79°50′55″ W. Not: Little Chestnut Creek (q. v.), North Fork Chestnut Creek.

North Mountain: mountain ridge, trends southwest for 24 miles, from the Potomac River, 3.5 miles north-northeast of Hedgesville, West Virginia, to the settlement of Green Springs, Virginia, 8 miles north of Winchester; Frederick County, Virginia, Berkeley County, West Virginia; 39°36′15″ N., 77°58′-15″ W. (northeast end), 39°18′15″ N., 78°10′-00″ W. (southwest end). Not: Little North Mountain.

Old Mill Pond: pond, 0.4 mile long, on the course of Skimino Creek, 7 miles north-northwest

of Williamsburg; James City and York counties, Virginia; 37°22′10″ N., 76°44′35″ W. Not: Wabden Pond.

**Old Root Narrows*: channel, 1.3 miles long, connecting Powells Bay and Ballast Narrows, 5 miles southwest of Chincoteague; Accomack County, Virginia; 37°53′35″ N., 75°27′12″ W. (east end), 37°53′45″ N., 75°28′25″ W. (west end). Not: Root Narrows (former decision), Roots Narrows, Root's Narrows.

Philbates Creek: stream, 1.3 miles long, heads at Goddins Pond, flows northeast to the York River 3 miles south-southeast of the town of West Point; New Kent County, Virginia; 37°29′24″ N., 76°47′05″ W. Not: Fillbate Creek, Fillbates Creek.

†Piankatank River: stream, 23 miles long, heads at the mouth of Dragon Swamp in Meggs Bay, flows east-southeast to Chesapeake Bay, at Gwynn Island, 45 miles north of Norfolk; Gloucester, Mathews, and Middlesex counties, Virginia; 37°32′30″ N., 76°17′30″ W.

Porterfield Branch: stream, 2.5 miles long, heads at 37°26′05″ N., 80°26′03″ W., flows south-southeast to Little Oregon Creek 1 mile northwest of Maggie; Craig County, Virginia; 37°25′50″ N., 80°23′40″ W.

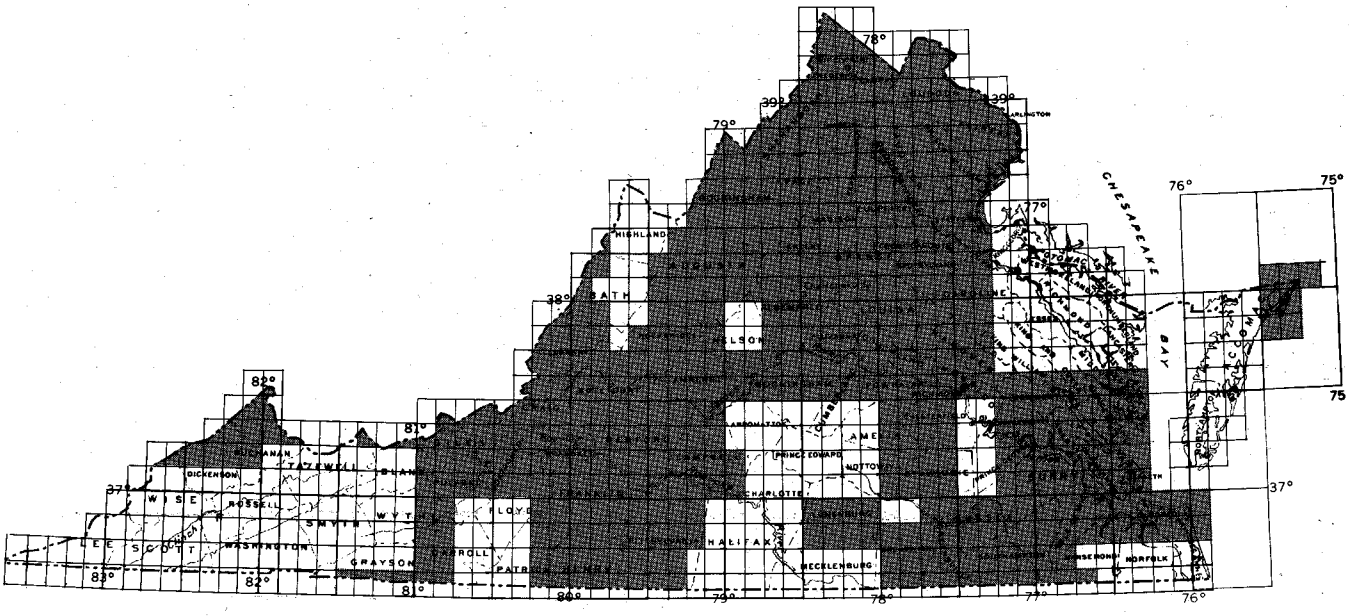
Porters Crossroads: settlement, 2 miles north-northwest of Ivanhoe and 8 miles southeast of Wytheville; Wythe County, Virginia; 36°51′52″ N., 80°58′58″ W. Not: Porter, Porters Cross Roads.

Queen Sound Channel: channel, 1.5 miles long, between Chincoteague Bay and Chincoteague Channel, just east of Shelly Bay, 1.5 miles west of Chincoteague; Accomack County, Virginia; 37°55′30″ N., 75°24′50″ W. Not: Queen Sound.

Rich Branch: stream, 0.5 mile long, heads at 37°29′10″ N., 80°18′50″ W., flows south-southeast to West Branch Grannys Creek 1 mile west-southwest of the settlement of Craig Springs; Craig County, Virginia; 37°28′40″ N., 80°18′32″ W.

Roanoke Mountain: north-south trending mountain, 2.5 miles long, highest elevation 2193 feet, in the Blue Ridge 4 miles south of the center of Roanoke; Roanoke County, Virginia; 37°12′34″ N., 79°56′09″ W. Not: Yellow Mountain.

AERIAL PHOTOGRAPHY



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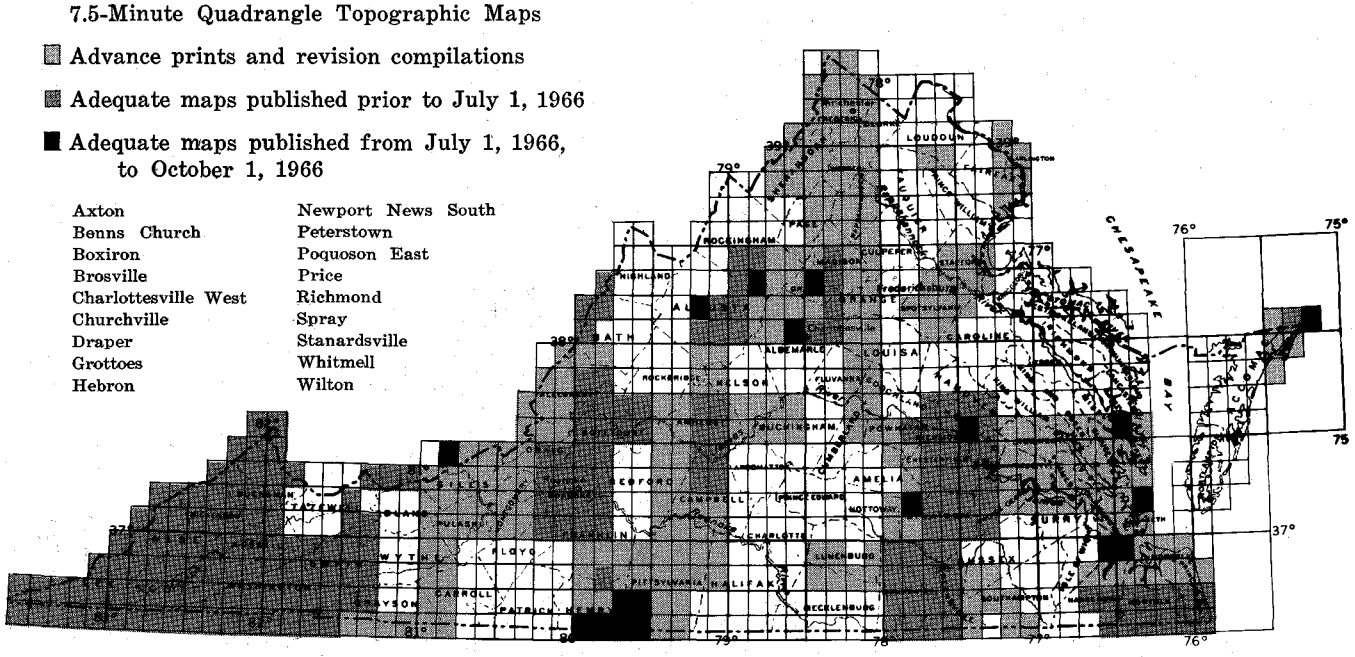

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